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Measures to assess wellbeing in low-carbon-dioxide cities

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Policies aimed at reducing carbon dioxide emissions often focus on the need to change existing behaviours and social practices as well as to provide technological advances in energy supply, waste, transport, industry and infrastructure. While fundamentally important to the mitigation of climate change, little is written about the impact that achieving carbon dioxide reduction targets, particularly for the built environment, will have on individual and societal wellbeing and quality of life. This paper investigates how a set of measures can be developed to assess wellbeing in cities, both as they are at present and as they transition to 'low-carbon-dioxide' futures. It outlines the important relationship between wellbeing, low-carbon-dioxide development and the built environment. A strategy for obtaining and assessing wellbeing measures is explained, the measures are discussed and 100 selected measures are detailed. The paper ends by illustrating how these measures can be integrated into a wider study of wellbeing.

1. Introduction

With the introduction of the Climate Change Act in 2008 and a plan to transition to a low-carbon-dioxide country in 2009, the UK government began developing a route map that focused on emissions reductions, resource security, economic opportunities and the protection of vulnerable groups (Climate Change Act 2008, 2008; DECC, 2009). The UK is not alone in this endeavour; many countries have formulated, or are beginning to consider formulating, policies around the 'low-carbon' and climate change agendas, and are setting targets for reducing the amount of non-renewable fossil fuels they use (Ellis *et al.*, 2009), and transitioning to low-carbon futures (Bulkeley *et al.*, 2013). Numerous cities and local governments also have signed up to reduce their carbon dioxide emissions (Bailey *et al.*, 2012; Dhakal and Shrestha, 2010; Gomi *et al.*, 2010; LSE Cities, 2012).

To achieve the IPCC (2007) 80% carbon dioxide reduction targets in the developed world, scientists, policymakers, advocates and academics suggest that technological, societal and behavioural changes will need to occur (e.g. greater investment in low-carbon infrastructure, and reconsidering governance systems) (DECC, 2009; Platt *et al.*, 2011; Urry, 2011, 2013). While such adaptations to the way we live may result in carbon dioxide reductions, there is uncertainty regarding the impact on our quality of life, and individual and societal wellbeing. To date, this issue has only been discussed at the conceptual level and using anecdotal case studies, and has not been explored empirically (see Aked *et al.*, 2010; Cabe, 2009a, 2009b, 2009c; Urry, 2011). Through original research from the UK Engineering and Physical Sciences Research Council (EPSRC)-funded 'Liveable Cities' programme grant, the authors aim to provide empirical evidence that suggests a relationship between transitioning to a low-carbon future and wellbeing within cities, and offers a way of measuring the impact.

This paper first provides definitions for relevant terms and outlines the literature on wellbeing as it relates to the built environment and low-carbon development. The research strategy for gathering and selecting wellbeing measures is explained next. The measures are then introduced and explained in more detail. The authors' 100 measures are shown in the final section, with a discussion of shortcomings and about how the

measures can be – and are being – incorporated into research on wellbeing in cities.

2. Definitions

For the purposes of this paper, the following key terms are defined and clarified.

'The built environment' refers to objective and subjective characteristics of the physical context in which people spend their time, including aspects of urban design, land use and transportation. It also shapes and is shaped by patterns of human activity (adapted from Davison and Lawson, 2006; Handy *et al.*, 2002). Two built environment scales that are relevant for this paper are the 'city' – the product of a socio-organisational process of urbanisation (Harvey, 1996) that is expressed territorially as well as economically, socially, politically and ecologically (Park, 1925) – and the 'neighbourhood' – 'a delineated area within physical boundaries where people identify their home and where they live out and organise their private lives' (Power and Bergin (1999), p. 9; see also Kearns and Parkinson (2001) for a discussion of the multi-scalar nature of neighbourhoods).

'Low-carbon development' involves addressing and integrating climate change into traditional planning and development objectives to propose development solutions that have lower emissions trajectories (Morita *et al.*, 2001).

'Low-carbon city' is an urban model, much like the eco-city or the smart city, that emphasises compactness and mixed use alongside significantly reduced, carbon-dioxide-intensive energy consumption and minimal greenhouse gas emissions. Based on principles of sustainable urban development, it also underscores the use of finite resources as well as the reuse of resources where possible, and endeavours to achieve homeostasis with the ecosystem (Lehmann, 2015.)

'Wellbeing' may be described as a positive physical, social and mental state that occurs when several basic needs are met (e.g. education or shelter) and one perceives a sense of purpose, including being able to achieve important personal goals and take part in society (Defra, 2010).

3. The relationship between wellbeing, the built environment and low-carbon development

A number of reviews have been published in the past few years that highlight the correlational (and sometimes causal) relationship between wellbeing and the built environment (see Anderson, 2013; Bowler *et al.*, 2010; Codinhoto *et al.*, 2009; Cooper *et al.*, 2008, 2011; Day *et al.*, 2000; Daykin and Byrne, 2006; Devlin and Arneill, 2003; Evans *et al.*, 2003; Joseph, 2006; Kaczynski and Henderson, 2007; Lawton, 2001; Staricoff *et al.*, 2003; Staricoff, 2004; Teresi *et al.*, 2000; Ulrich *et al.*, 2004; Weinstein, 2001; Wells, 2000). Much of the relational evidence presented tends to focus on negative aspects, such as poor-quality housing, noise, damp, air quality, temperature, pollution and fear. Thus, in most, but not all, cases, people have experienced distress, depression and elevated levels of stress from being exposed to the above variables. However, there are studies that concentrate on positive aspects (e.g. exposure and access to nature (Kaplan, 2001; Kuo, 2001; Van den Berg *et al.*, 2003; Wells and Evans, 2003; see Cooper *et al.*, 2008, for additional studies)).

Much less has been written about the three-way relationship between wellbeing, the built environment and low-carbon development. This may be because low-carbon development is a relatively recent phenomenon and greater emphasis has been placed on how cities, countries and the planet will adapt to uncertain futures, rather than to how adaptation will affect citizens' wellbeing. Nonetheless, discussion around the impacts of embodied carbon in building materials and the carbon footprint of our built environment has prompted questions about what can be done to reduce the impact of carbon on the environment, the economy and people's lives (Aked *et al.*, 2010; WHO, 2011). With current examples, such as BedZED (Beddington Zero Energy Development) in Sutton, UK (Aked *et al.*, 2010), suggesting that low-carbon developments also can foster social interaction, there are ways to design the built environment so that it responds to climate change and also helps with social (and economic and environmental) issues to engender more efficient, resilient places (Cabe, 2009c).

Within the field of healthcare, Cabe (2009a, 2009b, 2009c) has shown that thinking wisely about the physical fabric of cities and neighbourhoods can broadly improve public health. Doing so within a low-carbon development framework – while difficult to accomplish due to the often-competing motives of decision-makers and stakeholders, the cost of infrastructure adaption and the willingness of stakeholders to change behaviours – also may have positive implications for wellbeing (Community Health Partnerships, 2008). However, if development continues in a business-as-usual fashion, the built environment in cities may exacerbate already-existing problems (e.g. increased carbon dioxide emissions from private transport), thus increasing the likelihood of costly mitigation (Stern, 2006), and facilitating a decrease in wellbeing and quality of life.

Although this three-way relationship is being discussed within the built environment and healthcare sectors to some extent and other industries are beginning to take notice, there is a lack of concrete testing and empirical evidence to demonstrate that transitioning to a low-carbon built environment also positively impacts wellbeing. In the next section, the authors

discuss their approach for empirically assessing wellbeing within built environments, and whether features of low-carbon development support better wellbeing and quality of life among residents.

4. Research strategy

The authors followed the four-step process of Coombes and Wong (1994) for systematically determining the selection of wellbeing measures: step 1, conceptual consolidation; step 2, analytical structuring; step 3, indicator identification; and step 4, index creation. In step 1 (conceptual consolidation), the basic concept to be studied – wellbeing – was undertaken through literature reviews before proceeding to step 2. For this step (analytical structuring), the authors began their methodical search of wellbeing and wellbeing-related measures by using an online search engine. Terms, such as 'wellbeing', 'happiness', 'quality of life', 'life satisfaction', 'questionnaire', 'survey', 'checklist', 'inventory', 'scale', 'index', 'indicator' and 'measure' were entered into the search engine, including plural forms of relevant words. In addition, the authors knew of several surveys that are or were being administered, so included them in their list of measures. Finally, through a review of the academic literature on wellbeing, several surveys were referenced, and added to the list. From this search, 2288 measures from 98 different sources were found and collated.

With all of the measures added to an Excel spreadsheet, the authors moved to step 3 (indicator identification), where they reduced the number to a feasible amount, as the idea is to use a set of measures to assess wellbeing in cities, both as they are now and in low-carbon scenarios. Reducing the amount involved rigorously assessing each measure and deciding if it was related to wellbeing, the built environment and low-carbon development. To do this, the authors looked to four influential sources – Aked *et al.* (2010) and Cabe (2009a, 2000b, 2000c) – and found 30 issues that could be grouped together in two, relevant, built environment scales (12 at home/building scale and 18 at neighbourhood/city scale):

Home/building scale

- Use service space efficiently.
- Use renewable energy and sustainable materials.
- Use passive design techniques.
- Consider weather and temperature fluctuations.
- Use interesting and local architectural design.
- Is comfortable rather than institutional.
- Put people in contact with the natural environment.
- Exploit natural light, and use natural ventilation wherever possible.
- Create places with strong identity and local character to promote feelings of place attachment.
- Make services accessible and efficient.
- Design adaptable accommodation.
- Improve staff recruitment and retention, and increase morale.

Neighbourhood/city scale

- Develop a city-wide hierarchy of acute primary and community health facilities that join up delivery of services from hospital to home alongside other public amenities and public transit infrastructure.
- Create inclusive, accessible places with relevant services that encourage travel by foot, bicycle or public transport and that discourage motor traffic.
- Green space – and, indeed, all public spaces – should be budgeted, planned and carefully designed.
- Keep green spaces public, not privatised.
- Integrate city-wide networks of planting and green infrastructure.
- Encourage organised activities in parks and open spaces.
- Provide quality play spaces for all ages.
- Use programmed activities in well-designed and maintained public spaces to increase local pride, sense of safety and neighbourhood identification.
- Create social hubs and spaces for social networking and interaction.
- Facilitate interaction with street layouts.
- Avoid blank frontages.
- Position windows to overlook public routes and spaces.
- Use good street lighting.
- Develop shared energy resources.
- Use traffic calming measures to reduce traffic speeds in residential and built-up areas.
- Use home zones to prioritise pedestrian movement and make communities less dominated by traffic.
- Ensure pedestrian and cycling routes connect local services to residential development.
- Use interesting and local urban design features.

The above issues – found in some of the definitions for wellbeing, the built environment and low-carbon development/cities at the beginning of this paper, as well as in the relevant literature – were added to the Excel spreadsheet as columns, acting as criteria for selecting relevant measures, which were in separate rows. For each measure to be considered relevant, it had to address an appropriate number of criteria. Since some measures were better represented at one scale as opposed to another scale, the total number of criteria addressed may be low. However, at one scale, the measure might have addressed many criteria; thus, it would be selected. Those measures that overlapped both scales and addressed many criteria at both scales also would have been selected.

Before the measures were selected outright, the authors asked two more questions.

- Is the measure duplicated by another measure in the category (e.g. 'life expectancy' and 'healthy life expectancy')?
- Will the data for the measure be easy to collect (e.g. found on a government website)?

The first question allowed the authors to group similar-sounding measures together and to make a decision about how best to word the measures for the sake of obtaining data about the wellbeing of cities. Responses to the second question meant that the authors would end up selecting those measures that overlapped with many of the criteria and which also could be found without too much trouble. One limitation to selecting measures in this manner is that data for more difficult to obtain measures – measures that might uncover richer, more interesting aspects about the wellbeing of people in cities – might not be collected.

Finally, in an effort to group the measures together, rather than create a large list based on the above analysis, the authors moved to step 4 (index creation) and created an index of categories. Like the measures, the categories were analysed to ensure that they made sense, responding to the following question and sub-questions.

(*a*) Does the category make sense?

(i) Can the category fit into another category?
(ii) Should the category be split into one or more categories?
(iii) Does the category fit with the wellbeing, built environment and low-carbon agenda?
(iv) Does the measure fit the category?

Based on the above questions, 30 categories were created and 21 were used in taking forward the 100 measures.

5. The wellbeing measures in more detail

The 2288 measures were selected from 98 different sources from around the world that were measuring some aspect of wellbeing, happiness and/or quality of life. The sources ranged from those measuring wellbeing across countries (i.e. at the international scale) to those measuring wellbeing among individuals (i.e. at the sublocal scale). In three cases, sources overlapped at more than one scale (e.g. the North West Mental Wellbeing Survey contains questions at both regional and local scales).

From examining the different sources, over a third of the measures were found at the sublocal scale. These sources are often used by psychologists, psychiatrists and other healthcare professionals to understand how a client or patient is doing in terms of their mental health and wellbeing. The next most frequent scale was national, with many countries creating their own surveys to measure wellbeing. The third most frequent scale was international. Here, international bodies and organisations measure wellbeing and compare results across different countries or larger administrative boundaries. The remainder of the sources were found between sublocal and national scales, at local/sublocal, subregional and regional/local scales (see Table 1).

Scale range	Count	Example
International	20	Eurobarometer
National	29	Well? What do you think?
Regional/local	1	North West Mental Wellbeing Survey
Subregional	1	Illinois State Civic Index
Local	7	Place Survey
Local/sublocal	2	Wellbeing and Resilience Measure
Sublocal	38	Life Satisfaction Index

Table 1. Scale at which wellbeing measures were selected

Further analysis of the wellbeing measures revealed that approximately 75% were subjective; that is, the measures asked about feelings, life experiences, judgements and preferences (Dolan *et al.*, 2011; House of Commons Environmental Audit Committee, 2012; Michaelson *et al.*, 2012). The remaining 25% were objective measures, which refer to evaluations of the social context using measurable criteria (Dolan *et al.*, 2006, 2011; Houses of Parliament, 2012) that are independent of a person's perceptions (Weden *et al.*, 2008). Asking about a person's fear of crime in their neighbourhood is an example of a subjective measure; whereas, calculating actual crime rates in that same neighbourhood is an example of an objective measure.

In terms of the audience that the sources wished to target, the authors determined that 87% did not specify any demographic. That is, most sources did not direct their wellbeing measures at one or more audience. When the sources with no unspecified audience were removed from the equation, the following observations were made

- 37% targeted children or youth
- 19% targeted youth
- 17% targeted children
- 13% targeted children, youth and adults
- 6% targeted children and families
- 5% targeted older people
- 3% targeted adults.

Thus, of the 13% of sources that aimed to understand the wellbeing of a specific audience, 92% targeted children or youth in

some way. This is not surprising, given the spotlight on community development programmes and initiatives that have attempted to support children and youth since the 1950s (Coulton, 1995; Kubisch *et al.*, 1995), and organisations that monitor inequality and disadvantage among children and families (e.g. the UK National Children's Bureau).

Finally, in an effort to understand which areas of wellbeing were most popular among the 98 sources, the authors divided all the measures into 30 categories and counted the frequency of measures in each category. Some of the same measures were used by different sources, whereas others were distinct, yet still fit into one of the categories (see Table 2).

Psychological health contained the most wellbeing measures, with nearly 30% of the total measures represented. As stated earlier, this may be due to the prevalence of measures at the sublocal scale that healthcare professionals, including psychologists and psychiatrists, use when assessing the wellbeing of patients and clients. The next most frequent category was social support (almost 10% of the total measures), which is regarded as one of the main components of wellbeing (Defra, 2010; Fowler and Christakis, 2008; Government Office for Science, 2008); as such, there is likely to be great interest in better understanding how social support works in various contexts. The third most popular category was environment (representing approximately 9% of the total measures). As a result of the tangible nature of certain environmental features, such as the average concentration of particulate matter in cities, data from environmental measures may be collected more often than other, less concrete or valued measures.

Compared with the above, most of the remaining categories had relatively low quantities of wellbeing measures (i.e. less than 5% of the total measures; general health and community participation were exceptions with about 6 and 5%, respectively). In fact, some categories, such as food, information and knowledge, morals, and private services, only had one or two measures within their respective categories. This latter finding suggests that there are current gaps in the way wellbeing is defined and measured that could be examined in more detail. A more plausible reason – and one that was confirmed by analysing the categories – is that some categories did not make sense or were incorporated into already-existing and meaningful categories.

5.1 The measures used to assess wellbeing in (low-carbon) cities

Upon analysing all the wellbeing measures against the 30 criteria mentioned in the research strategy section, 100 measures were selected: 50 subjective wellbeing measures and 50 objective wellbeing measures. In addition, from the 30 categories highlighted in Table 2, 21 categories were selected. The 100 measures represent those aspects of wellbeing that have a relationship with low carbon dioxide and the built environment (see Table 3).

Category	Frequency of wellbeing measure	Percentage of total wellbeing measures: %
Community participation	122	5.33
Crime	100	4.37
Demographics	19	0.83
Domain-specific satisfaction	66	2.88
Economy	94	4.10
Education	44	1.92
Employment	41	1.79
Energy	10	0.44
Environment	199	8.69
Food	1	0.04
General health	146	6.38
General life satisfaction	40	1.76
Governance	6	0.26
Housing	65	2.84
Information and knowledge	1	0.04
Infrastructure	4	0.17
Morals	1	0.04
Physical health	36	1.57
Planning	9	0.39
Political participation	87	3.80
Private services	2	0.09
Psychological health	679	29.65
Public services	93	4.06
Social support	226	9.87
Society and tolerance	29	1.27
Spirituality	6	0.26
Standard of living	35	1.53
Transportation	51	2.23
Work	10	0.44
Work–life balance	64	2.79
Total	**2228**	**100.00**

Table 2. The frequency and percentage of wellbeing measures per category

6. Conclusions: how the measures can be integrated into a wider study about the assessment of wellbeing in (low-carbon) cities

It is clear from this analytical review of measures that the concept of wellbeing is extremely broad and multi-dimensional, and that it is not feasible to use 2288 measures in any survey

Category	Measure
Community participation	■ How would you describe your sense of belonging to your neighbourhood?[a] ■ What sorts of things stop you from doing any activities you would like to do?[a] ■ Percentage of people who feel they belong to their neighbourhood
Crime	■ How safe do you feel walking alone in this area… after dark?[a] ■ … during the day?[a] ■ … in [city]?[a] ■ It is safe to be out and about on the streets?[a] ■ Personal crime rate ■ Percentage of children who feel safe going to/from X
Demographics	■ Number of inhabitants
Domain-specific satisfaction	■ Please tell me how satisfied you are with… your home/housing[a] ■ … your health[a] ■ How satisfied are you with… how safe you feel?[a] ■ … the basic services offered by your local authority?[a] ■ In general, how satisfied are you with the way your local authority is doing its job[a] ■ On a scale of 0 to 10, how satisfied are you with your present standard of living?[a] ■ How satisfied are you with your local area as a place to live and work?[a]
Economy	■ [City] spends its resources in a responsible way[a] ■ Household/family income ■ Wages for different demographics ■ Poverty rate ■ Private investment in dwellings
Education	■ How happy are you about the school that you go to?[a] ■ Literacy rate ■ Highest degree awarded
Employment	■ Unemployment rate ■ Percentage of the working age population in employment
Energy	■ Greenhouse gas per household ■ Average total energy consumption of buildings ■ Energy consumption for transport
Environment	■ In your city or area where you live, are you satisfied or dissatisfied with the beauty or physical setting?[a] ■ It is important to me that I can be proud of my local environment[a] ■ Do you live within a 10 min walk of a natural blue or green space?[a] ■ What do you think of the parks/play areas in your area?[a] ■ My local area is safe for children to play outside[a] ■ [City] is committed to the fight against climate change[a] ■ Average ecological footprint ■ Populations living in areas with, in relative terms, the least favourable environmental conditions ■ Percentage of wards in the 10% most deprived areas ■ Percentage of households satisfied with the quality of the places in which they live
General life satisfaction	■ Overall, how… satisfied with your life were you 5 years ago?[a] ■ … optimistic do you feel about the next 5 years?[a] ■ All things considered, how satisfied or dissatisfied are you with your life as whole nowadays?[a] ■ On which step of the ladder would you say you personally feel you stand at this time?[a]

Table 3. Wellbeing measures by category (continued on next page)

Category	Measure
Housing	■ How important is housing quality to quality of life, both now and in the future?[a] ■ My (family's) home is nice[a] ■ I wish I lived in a different house[a] ■ Total resident population per km^2 of built-up area ■ Share of total population/households living in substandard/unfit housing ■ Satisfaction of people over 65 with both home and neighbourhood
Physical health	■ Percentage of people who report daily physical activity
Planning	■ How important is more building in the countryside to quality of life, both now and in the future?[a] ■ Share of sustainably classified buildings of all new and renovated buildings ■ Presence of an integrated plan in the city
Political participation	■ Which of the following political activities, if any, have you done during the last 12 months?[a] ■ How much influence do you have over the quality and variety of local sporting facilities?[a] ■ Participation rates in most recent election
Psychological health	■ I love doing things that stimulate my senses[a] ■ I feel a sense of pride in the way my city looks and feels[a]
Public services	■ In general, how would you rate the quality of… state childcare services in [country]?[a] ■ … public health services?[a] ■ … care services for elderly?[a] ■ … sports facilities?[a] ■ … local education services?[a] ■ … council housing?[a] ■ Spending for sporting and cultural facilities ■ Number of people living near open spaces ■ Numbers of visitors to national parks/historic sites
Social support	■ On average, about how many people do you have contact with in a typical week day, including people you live with?[a] ■ I feel close to the people in my local area[a] ■ My parents and I doing fun things together[a] ■ Have you been bullied at school? ■ Percentage of people who believe people from different backgrounds get on well together in their local area ■ Perceptions that people in the area treat one other with respect and dignity
Society and tolerance	■ My local area is a place where people from different racial and ethnic and religious backgrounds mix well together[a] ■ Proportion of people who feel that racial or religious harassment is a problem in the local area ■ Proportion of people from ethnic minority groups who feel that racial or religious harassment is a very or fairly big problem in the local area
Standard of living	■ Household… computer access ■ … Internet access ■ … broadband access ■ Proportion of the population living in the most deprived super output areas in the UK ■ Percentage of the population… that live in households that are income deprived ■ … of working age that is claiming key benefits ■ Average amount of money that a household earns per year, after taxes

Table 3. Continued

Category	Measure
Transportation	■ How satisfied are you with the accessibility of public transport?[a] ■ How important is road traffic to quality of life, both now and in the future?[a] ■ In general, how would you rate the quality of… the public transport system?[a] ■ … the infrastructure?[a] ■ Why don't you use public transport? (list several reasons)[a] ■ Annual transit cost ■ Vehicle miles travelled per household ■ Length of roads and cycle paths ■ Mode of transport used by households ■ Number of fatal injuries per million vehicle kilometres ■ Average density of vehicles on the road per kilometre
Work	■ Working hours
Work–life balance	■ Time/week for… sleeping ■ … working ■ … leisure ■ Have you been to a local park or playground in your free time in the last 4 weeks?

[a]These measures are subjective wellbeing measures

Table 3. Continued

of wellbeing. Therefore, it is essential to focus the assessment of wellbeing on a specific intervention or location. The 100 wellbeing measures listed in Table 3 can be used to begin to explore how people feel about or perceive a range of topics relating to wellbeing (i.e. the subjective measures) as well as independent information about the places in which people live (i.e. the objective measures). Few studies have considered both subjective and objective measures simultaneously in terms of the relationship between wellbeing and the built environment (Weden *et al.*, 2008), and none has explored the three-way relationship between wellbeing, low carbon and the built environment. Using both kinds of measures should result in a better reflection of the characteristics of people within cities and neighbourhoods, as well as the qualities of cities and neighbourhoods, themselves, as opposed to using just subjective or objective measures (Weden *et al.*, 2008). Moreover, the integrated suite of measures gives decision-makers, policymakers and other stakeholders the opportunity to better understand how the built environment of their city is performing in terms of wellbeing *and* low carbon dioxide. Without the check on how wellbeing might be impacted, low-carbon policies may be enacted that reduce carbon dioxide but increase 'illbeing'.

While this research breaks new ground in the assessment of wellbeing, low carbon and the built environment in cities and neighbourhoods, it is important to acknowledge three shortcomings with this approach. First, residents of different wards may perceive their neighbourhoods quite differently. In particular, research has shown that people living in more deprived areas have more restricted socialisation patterns, have weaker social networks outside their neighbourhoods and are more inward-looking than residents living in less deprived areas (Atkinson and Kintrea (2000); compare with Atkinson and Kintrea (2001) for greater nuance of this area effect). In this sense, the neighbourhood as defined by Power and Bergin (1999) earlier in this paper may be perceived as smaller by residents of high-deprivation wards as opposed to low-deprivation residents. Thus, how residents of high- as opposed to low-deprivation wards respond to and interpret the subjective wellbeing measures in Table 3 may reflect differences in the perceived size of their respective neighbourhoods.

Second, the overestimation and underestimation of neighbourhood effects needs more attention. Weden *et al.* (2008) suggest that a person's wellbeing may be determined just as much from his/her individual characteristics as the neighbourhood in which he/she lives. To emphasise individual factors, such as age or education, without controlling for individual-level demographic variables, means that any statistically significant findings may overestimate the impact of the

neighbourhood on wellbeing. However, controlling for individual-level variables may lead to an underestimation of neighbourhood effects if differences in individuals (e.g. as regards age or education) translate into differences in wellbeing that actually originated in the neighbourhood conditions (e.g. a person receives a better education in part due to the wealth of educational resources in his/her neighbourhood). Using a large dataset may help in alleviating such over- and underestimations, generating a more statistically robust analysis.

Third, although both subjective and objective wellbeing measures are being used, *inter*subjective measures have not been considered. Particularly as the concept of low-carbon development, defined at the beginning of this paper, is perceived to be part of an organisational or system-based set of beliefs, values and culture, it will be difficult to understand the private experiences of the 'other', or 'self-contained' groups (e.g. residents living in high-deprivation wards). To some extent, however, this issue is moderated by the use of (inter)-objective measures, as these measures embody the notion that perceptions and behaviours are regulated by normative systems (i.e. the collective, cultural experience in which individuals are socialised) (Moghaddam, 2003, 2010). Thus, collecting objective wellbeing measures can assist in better understanding the 'other'. Nonetheless, the issue of intersubjectivity and interobjectivity, pertaining to the relationship between wellbeing, low carbon and the built environment, requires further study.

One other way potentially to address the third shortcoming is to add further, objective data. Given the importance of the relationship between wellbeing and the built environment (Cooper *et al.*, 2008, 2011; Evans *et al.*, 2003), it makes sense to evaluate those features of the built environment that relate to wellbeing and low-carbon development. This is where an audit of the environment would be useful; in principle, by objectively assessing the provision of goods in an area, such as the presence, quality and access of pavements and parks, more information about the context in which people live, work and recreate becomes known (cf. Lewis (2011) for the value-laden nature of built environment audits). A good scale at which to audit the built environment, therefore, would be the neighbourhood, which primarily includes an evaluation of public spaces that people may use within a certain radius of their house. Such an integrated approach allows for both top-down ((inter) objective measures; audits) and bottom-up (subjective measures) methods, and creates a more holistic picture of wellbeing within an area (Scott, 2012) while also going some way to satisfy the issue of intersubjectivity. This is precisely what the authors are doing as part of the UK EPSRC-funded research programme grant called 'Liveable Cities'. The authors are currently undertaking three, in-depth case studies of UK cities and wards/neighbourhoods within those cities. They are collecting data using

- 50 objective wellbeing measures about each city (and neighbourhood where data are available) using data from different sources (e.g. ONS Neighbourhood Statistics)
- 50 subjective wellbeing measures by way of a wellbeing questionnaire to be administered to residents of each city (residents will be contacted through local authority ward support officers as well as community groups)
- built environment audits, containing about 60 questions, of the selected neighbourhoods within each city.

Based on previous research (see Boyko and Cooper, 2011, 2012, 2013; Cooper *et al.*, 2008, 2009, 2011), the authors found that dwelling density and deprivation were important issues in the relationship between wellbeing and the built environment, and wanted to understand whether and how low-carbon development played a role in that relationship. They have chosen neighbourhoods within the selected cities that differ with respect to density and deprivation, creating four, distinct places in which to collect data: a low-density, low-deprivation neighbourhood; a low-density, high-deprivation neighbourhood; a high-density, low-deprivation neighbourhood; and a high-density, high-deprivation neighbourhood. Once all of the data have been collected and analysed, the authors will obtain a sense of how cities and neighbourhoods are performing in relation to wellbeing, low-carbon development and the built environment today. The next step in this multi-phase research inquiry will be to use scenarios-based work with other members of the 'Liveable Cities' team to consider what the future might hold for cities and neighbourhoods in terms of low-carbon development that also enhances wellbeing. From here, it will be possible to backcast to the present to develop designs and policies that will take us to that future: a liveable, wellbeing-prioritised, low-carbon tomorrow.

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